



Nordic Benthological Meeting VIII

Book of Abstracts : food webs and climate change, Aalborg, Denmark, 9 - 12 May, 2011

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Book of Abstracts



Nordic Benthological Meeting VIII

Food webs and climate change

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Session I

Food webs, climate change and diversity of stream communities

CLIMATE CHANGE IN FRESHWATERS: IMPACTS ACROSS MULTIPLE LEVELS OF ORGANIZATION

Dr. Guy Woodward

Queen Mary University of London, United Kingdom

Climate change is a complex integrated stressor, comprised of several component parts, including: changes in environmental temperature, ecological stoichiometry between consumers and resources, and hydrology. These different drivers can all influence the higher (multispecies) levels of biological organisation in fresh waters, both individually and in combination. In addition, climate change is also often accompanied by a range of biotic stressors associated with local invasions and extinctions, as species populations move between new climatic zones. However, surprisingly little is known about the effects of climate change at the community, food web or ecosystem level, with most ecological studies to date being conducted at the lower (individual or population) levels. In this talk I will attempt to outline how we can address these gaps in our knowledge, and, in particular, how we might be able to do so in a more systematic manner within a coherent theoretical framework. I will draw on some recent studies that have been conducted at the higher organisational levels, using a range of approaches, from experimental manipulations, to natural experiments and surveys, and mathematical modelling, to illustrate how these may be integrated to provide new insights.

Although our understanding of the effects of climate change on freshwater ecosystems is still in its infancy, some recurrent patterns are emerging from empirical studies and theoretical developments are moving forward apace: this offers promise for further advances in the near future, as we try to grapple with what is undoubtedly one of the most serious threats faced by freshwater ecosystems in the 21st century.

BETA-DIVERSITY OF BENTHIC INVERTEBRATES IN FOREST STREAMS: A COMPARISON BETWEEN FINLAND AND NEW ZEALAND

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Beta-diversity is a basic concept of community ecology that has been much debated recently. We assessed beta-diversity of stream benthic invertebrates using two geographically distinct data sets, one from Finland and one from New Zealand, collected using strictly standardized field protocols. Both data sets consisted of 15 stream sites sampled in each of eight watersheds distributed across 1100-1500 km in each country. We used a measure of beta-diversity that is independent of variation in alpha-diversity ('effective species turnover'), and partitioned regional diversity into its alpha- and beta components. The watershed-scale gamma diversity was about the same in both countries whereas mean alpha-diversity was generally slightly higher and beta-diversity lower in New Zealand. The higher beta-diversity in Finnish streams might be related to greater among-region variation in local environmental conditions. In Finland, beta-diversity did not vary along south-to-north gradient, except that it was highest in the most human-impacted, southernmost watershed (River Vantaanjoki). In New Zealand, beta-diversity increased southwards. It was unrelated to regional variation in local habitat diversity but was correlated to regional differences in valley topography, a factor likely related to among-stream dispersal of stream invertebrates.

CHANGES IN FISH BIODIVERSITY AND COMMUNITY STRUCTURE IN A BOREAL HEADWATER STREAM SYSTEM: A 26 YEAR PERSPECTIVE

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Freshwater systems have suffered greater losses of biodiversity and impairment of ecosystem functionality than most other systems worldwide. Nevertheless, rigorous studies on long-term community changes of aquatic systems are sparse. By carefully re-sampling a fish community data set originally collected in 1982-83 we were able to document community changes and loss of fish diversity in a boreal watershed. The 28 studied riffle sites situated in 11 streams in North-Eastern Finland showed a decrease from 3.0 to 2.4 in the average number of species. Only core species were considered and those occurring only once were deleted from analysis. The burbot (*Lota lota*) showed the steepest decline, falling from 89 to 57 percent site occupancy. Also fish densities of many species showed a clear decline with the brown trout (*Salmo trutta*) being the exception, likely due to intensive stocking. Preliminary results suggest changes in water chemistry as a potential factor behind the observed changes in fish communities.

TEMPORAL VARIABILITY IN TAXONOMIC COMPLETENESS OF STREAM MACROINVERTEBRATE ASSEMBLAGES

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Many bioassessment methods are based on estimates of taxonomic completeness (i.e. comparison of observed to expected taxa number). Expected community composition is derived from a set of reference sites, usually sampled over a short period of time, and it is uncertain whether the reference condition thus defined can be extrapolated across years. We assessed the long-term variability in taxonomic completeness using a RIVPACS-type predictive model. To define the reference condition, we used data collected in 2001 on benthic macroinvertebrate assemblages in 51 near-pristine streams in northern Finland. The model performed generally well in predicting taxonomic completeness of 24 independent, unmodified test sites in the same year. When applied to a data set from the same 24 streams across ten years, annual variation in taxonomic completeness was generally low when compared to spatial (among-site) variation, the only exception being year 2006 with record-low stream flows. However, at ten modified streams with a 4-yr data set, assessment of the biological status varied through time. Thus, although temporal variation of reference sites was well characterized by one-year data, modified sites behaved more erratically through time, suggesting that assessments based on single-year samples may not represent well the true biotic condition of sites modified by human disturbance.

THE HEAT IS ON: RIVER ECOSYSTEM RESPONSES TO GLACIAL RETREAT

Dr. Lee E. Brown
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Glaciers are distributed worldwide and, as they store about 75% of the world's freshwater, they contribute significantly to river flow and water resource availability. Glaciers can maintain river flow during the summer when many rivers in non-glacierized basins are otherwise characterized by low flow. Rivers with meltwater inputs are ecologically important and of high conservation value because they provide important habitat for rare plants and animals, some of which are known to be endemic to specific regions. However, glacial rivers are vulnerable to climate change because of strong interconnections between atmospheric forcing, snowpacks/glacier mass-balance, stream flow, water quality and hydrogeomorphology, and river biota. Negative glacier mass-balance has been observed in most regions of the world over recent decades and can be attributed to a warming climate and changes in precipitation. These changes are leading to major shifts in water sourcing of rivers with glacier- and snow-melt reductions, proportionally greater groundwater and liquid precipitation contributions and changes in proglacial riverscape dynamics, all of which will lead to significant and widespread ecological change. This talk will summarize current understanding of how glacially influenced river ecosystems across the world can be expected to respond to glacier retreat, and will provide more detailed insights from long-term research projects undertaken in the French Pyrénées and southeast Alaska. The talk will consider some of the main implications of glacier retreat for aquatic ecosystem structure, functioning and conservation. It will also outline some of the ecological lessons that can be learned from studying rivers during glacial retreat, in particular ideas related to how aquatic communities assemble during primary succession.

Session II

Food webs, climate change and diversity of lake communities

BITTEN BY THE SAME BUG?: HIGHER TEMPERATURE STRONGLY AFFECTS THE STRUCTURE OF BENTHIC COMMUNITIES IN LAKES AND STREAMS

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Macroinvertebrates play a key role in the functioning of aquatic ecosystems, being consumers of primary producers (such as periphyton and macrophytes) and being selected prey for fish. They thus facilitate the linkage between habitats and potentially also between local trophic webs, particularly in shallow lakes with abundant macrophytes, but also in streams. Recent comparative field work in lakes and streams of temperate Denmark and subtropical Uruguay suggests that the structure of the benthic communities differ substantially with the climate regime, other environmental characteristics being similar. Colder systems (both lakes and streams) host richer local communities, with a wide body size spectrum, while warmer systems appear to host impoverished local communities in terms of taxonomic richness with extreme body sizes present (i.e. very small and very large taxa predominate). Food webs are also more truncated. We argue that indirect effects of higher temperature, namely higher predation pressure by fish, seem a key factor behind these patterns. The potential consequences for the functioning of aquatic systems under the climate warming scenario are manifold and will be discussed.

CONCORDANCE OF ASSESSMENTS OF LAKE LITTORAL AND PROFUNDAL MACROINVERTEBRATE ASSEMBLAGES

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Legislative mandates in Europe and elsewhere demand assessment and monitoring of lakes by benthic macroinvertebrate communities. However, there is little consensus on whether only littoral fauna, profundal fauna, or both, should be used. Macroinvertebrate communities at both habitats are fundamental functional elements of lake ecosystems, and moreover, the two habitats and their biota are likely to respond differentially to different disturbances. Thus, multihabitat assessment should be supported. On the other hand, focusing on only one habitat would reduce monitoring costs and be certainly appealing, particularly in Finland with 187 888 lakes. To assess the concordance of macroinvertebrate community variation and response to disturbances between the two habitats, we compiled available data from about 100 Finnish lakes sampled for both stony littoral and profundal macroinvertebrates. For both habitats we applied reference condition approach for the assessment of macroinvertebrate assemblage status, and evaluated whether the assessments showed similar pattern between the two habitat types in lakes subject to two different types of anthropogenic disturbance; water level regulation and eutrophication.

THE ROLE OF INTRODUCED SIGNAL CRAYFISH IN LITTORAL FOOD WEBS IN LARGE BOREAL LAKES

Timo Ruokonen¹, Heikki Hämäläinen¹ and Juha Karjalainen¹

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Freshwater crayfish have been spread widely beyond their natural distribution range and they can strongly affect native biota and ecosystem function. The North American signal crayfish (*Pacifastacus leniusculus* Dana) is spreading rapidly across Europe and involves negative impacts on freshwater ecosystems. In general, freshwater crayfish are supposed to be opportunistic omnivores in feeding habits, utilizing a wide variety of food sources from algae to fish. However, recent studies show that in some instances, benthic macroinvertebrates is the most important food source, and that direct predation might result in major impacts of crayfish on macroinvertebrate communities. Introduced crayfish, being a relatively large sized omnivore, might strongly alter natural littoral food webs particularly in habitats where crayfish is a new component of the fauna. In this study, we investigated the role of introduced signal crayfish in littoral food webs in two large boreal lakes, which have not previously inhabited by abundant crayfish populations. We investigated the contribution of different food sources to crayfish diet and trophic structure of the littoral food web, using stable isotope analysis. To investigate if the feeding of signal crayfish is reflected in the structure of benthic macroinvertebrate communities, we compared the littoral macroinvertebrate community composition between sites with crayfish and without crayfish. Our results suggest that signal crayfish at the shores of large lakes are primarily predators utilizing predominantly littoral food sources. The observed high trophic position and position among the benthic fish in the trophic structure indicates that crayfish use mainly animal food such as benthic macroinvertebrates. Our results also suggest that signal crayfish can alter community composition and reduce abundance of littoral invertebrates in large boreal lakes. As signal crayfish prefers warmer than the ambient climate in Boreal region, both the spatial range and size of impact could increase with warming climate.

PROFUNDAL MACROINVERTEBRATE ASSEMBLAGES OF BOREAL LAKES VARY WITH SHORT TERM CLIMATE OSCILLATION (NAO)

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Climate change is a severe threat to aquatic ecosystems. However, relatively little is known about the responses of freshwater biota to even short term climate variation. To evaluate if benthic macroinvertebrate communities in boreal lakes vary with inter-annual climate variation, we compiled available short term (6-19 years) time-series data on profundal macroinvertebrates from 125 Finnish lake sites; including sites with minimal disturbance as well as sites subject to varying human impact. Species data comprising of 133 taxa were used to calculate five metrics measuring different properties of communities (i.e. composition, stability, persistence, diversity and abundance). For each site, we used Spearman rank correlation analysis to relate community metric values to the winter time North Atlantic Oscillation (NAO) index of the corresponding year. The distributions of those correlations among sites were compared to the distribution of values derived from the site-specific correlations between the NAO and a randomised response variable. Community composition (DCA axis scores) and persistence (Sørensen dissimilarity) were not related to the NAO and did not differ from the random correlation values. In contrast, the Spearman r distributions of stability (Bray-Curtis dissimilarity), diversity (number of taxa) and abundance (chironomid and oligochaete abundance) were negatively skewed and the r values were significantly more negative than the random values. Our study suggests that some characteristics of profundal macroinvertebrate assemblages are sensitive to short term climatic oscillation and these associations might be of major importance for predicting the effects of climate change as well as for the assessment and conservation of aquatic ecosystems.

TOP-DOWN AND BOTTOM-UP PERTURBATION OF A QUANTIFIED HEADWATER FOOD WEB – EFFECTS ON STRUCTURE, FUNCTIONING AND PRODUCTIVITY

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Human impacts on aquatic ecosystems are manifold, often resulting in a change in the physical habitat and/ or the addition or deletion of species, both of which lead to changes in community structure and, ultimately, a modification of ecosystem processes. However, the link between the structure of communities and the functioning of ecosystems is not fully understood. Here, we report the results of a study of a heavily shaded headwater stream food web where we quantified the biomass and elemental quality of the structural components and the flux between them. After one year of monitoring, we manipulated the community by a controlled introduction of an “invasive” species near the top of the web (*Salmon salar*). This resulted in a decrease in the abundance of invertebrates, a decrease in both grazing rate and leaf breakdown rate and a shift in the diet of young of the year trout post-salmon introduction. The second manipulation was removal of approximately 75% of the tree canopy to increase light and took place when the salmon parr had left the stream. The canopy removal resulted in a fivefold increase in standing stock of benthic algae and a threefold increase in algal accrual. This increased availability of high quality resource (low carbon: nutrient) resulted in a fifty percent increase in in-stream invertebrate production. The results from this study indicate that perturbation of stream food webs effect not just structure but also functioning and productivity of stream ecosystems.

Session III

**River ecosystem process response to climate change
and human impacts**

RELATIONSHIPS OF MACROINVERTEBRATES WITH FLOW VELOCITY AND BOTTOM TYPE IN FRESHWATERS OF ESTONIA

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We developed an index (**MESH** - **Macroinvertebrates in Estonia: Score of Hydromorphology**) to assess hydromorphological quality in surface waters of Estonia, on the basis of taxonomical composition of macroinvertebrates. The existing quality estimation systems were either directed rather to organic pollution and/or general degradation of waterbodies, or were not transferable because technical reasons. The MESH is an average score, based on the affinities of selected indicator taxa to flow velocity and bottom type. These two measures were joined into one metric, because a very significant ($p < 0.0001$) correlation between them. The list of MESH indicators includes 394 freshwater macroinvertebrate taxa, derived from 3,282 samples, collected from different freshwaters during 1985–2009. The indicators were selected out of 690 taxa, by applying the information-theoretical Kullback-Leibler divergence to the data. The individual scores of macroinvertebrates range from 0–3, the higher scores indicating faster flow and/or harder bottom. Among the reference waterbodies, the mean MESH was the highest in small streams, followed by middle streams, large streams, and lakes. In lakes with medium water hardness (which type prevails in Estonia), the MESH decreased gradually from stony to muddy bottom. The highest MESH values in standing waters were observed in stony surf zone of very large lakes (area > 100 km²). The lowest values occurred in small lakes with exceptional hydrochemical characteristics (soft- and darkwater, and calcareous types). Similarly, MESH indicated well whether and how much some stream sites were degraded by damming. The mean MESH in the reservoirs with muddy bottom was significantly lower than that in the reservoirs with hard bottom, or in the unregulated stream sections. In future, we aim to develop corresponding reference values and quality levels for MESH in main types of surface waters in Estonia, in order to follow the requirements of European Water Framework Directive.

GOING INTO BATTLE WELL PREPARED – MACROPHYTE RECOVERY FROM HUMANLY INDUCED DISTURBANCES DEPENDS ON INITIAL PHYSICAL CONDITIONS

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We studied the effects of weed cutting at 3 reaches in two Danish lowland rivers with the objectives of examining the response to cutting in rivers with contrasting physical conditions, macrophyte diversity and assemblage patterns. Physical characteristics and abundance of macrophyte species were registered 3 or 4 times throughout the study period on all reaches.

Weed cutting did not affect the total coverage of stone, gravel and sand and substratum homogeneity and no common response was found among the reaches. This result is likely to reflect both initial differences in the physical environment among the reaches as well as differences in macrophyte coverage and assemblage patterns. Water depth, variability in current velocity and the coverage of stone and sand were affected by coverage independent of assemblage patterns, whereas the river bed substratum homogeneity was affected by coverage as well as assemblage pattern.

The analysis indicated that diverse macrophyte communities with several growth morphologies enhance the spatial variability in substratum characteristics compared to reaches with a less diverse and more homogeneous distribution of species.

THE ROLE OF RIPARIAN AREAS FOR THE ECOLOGICAL STATUS AND BIODIVERSITY OF STREAMS

Peter Wiberg-Larsen¹, Annette Baattrup-Pedersen¹, Søren Erik Larsen¹, Esben A. Kristensen¹

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Naturally flowing streams are closely linked to the adjacent areas, the linkage including hydromorphological, chemical and biological processes. In Denmark, without the influence of man riparian areas would be forested, interrupted by smaller areas covered with light demanding and species-rich herbaceous vegetation. However, during the last century this linkage between streams and riparian areas has been severely altered, making the riparian areas dry and vegetated by species-poor, nutrient demanding plant communities.

We analysed the influence of “light-open” EU habitat types located within a 30 m riparian zone on the ecological quality and biodiversity in the related streams, using data from 252 sites in the national monitoring programme. The habitat types included “rivers with muddy banks with *Chenopodium rubri* p.p. and *Bidens* p.p. vegetation”, “*Molinia* meadows on calcareous, peaty or clayey-silt-laden soils”, “transition mires and quaking bogs”, “calcareous fens with *Cladium mariscus* a.o.”, and “alkaline fens”.

Using regression and covariance analyses we demonstrated that the habitat vegetation types had a significant positive effect on the stream environment, including the number of amphibious plant species, number of EPT taxa (i.e. Ephemeroptera, Plecoptera and Trichoptera) and EPT individuals, Danish Stream Fauna Index, and the density of brown trout fry. However, the effect was not only indirectly through a positive influence on stream chemistry and physics (streams linked by nature being cleaner and physically undisturbed compared with those bordered by cultural meadows and cropped fields) that in turn is known to favour biodiversity and ecological status. Thus, there was a significant direct effect that may be related to the colonization of the amphibious streamzone by plant species from the habitat nature reserves, and to diverse riparian herbaceous habitats favouring the terrestrial life of EPT taxa, including their feeding, swarming, and demand for shelter against enemies. This confirms that management of the stream environment must be planned and carried out in close connection with the riparian areas, which is also presupposed in the EU Water Framework Directive.

BUFFER STRIP WIDTH AND AGRICULTURAL PESTICIDE CONTAMINATION IN DANISH LOWLAND STREAMS: IMPLICATIONS FOR STREAM AND RIPARIAN MANAGEMENT

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Non-point source contamination with agricultural pesticides is widely acknowledged as one of the greatest sources of pollution in stream ecosystems, and surface runoff is an important transport route. Mitigating the risk of non-point source contamination by agricultural pesticides in surface waters is essential to comply with the WFD. Recently, the SPEAR index was introduced for German streams aiming specifically to detect pesticide impact in streams among a multitude of environmental stressors. In subsequent field studies, SPEAR was successfully linked to pesticide toxicity in terms of toxic units (TU).

In this study we characterise the occurrence of agricultural pesticides (in water and stream sediments) and toxicity (TU) in 15 Danish low-order streams representing a gradient in potential pesticide contamination as inferred from the percentage of agricultural land in the catchment. We use these data to 1) analyse linkages between pesticide findings and land-use characteristics at various scales including catchment, field and buffer strip and 2) to analyse to what extent buffer strips can be used to mitigate pesticide losses to lowland streams.. Furthermore we analyse if the predictive power of a pesticide surface-runoff model (RP) can be enhanced by adding information on buffer strip characteristics.

Measured pesticide toxicity (TU) ranged from -1.57 to -6.5 in the investigated streams caused by primarily herbicides and fungicides. Preliminary analyses show that the strongest predictor of TU was minimum buffer strip width (BSW) ($P < 0.001$) followed by percentage of agricultural land and applied amounts of pesticides ($P < 0.05$) in a 2x100 m stream corridor extending 1,000 m upstream. The RP model significantly predicted TU of detected pesticides ($P < 0.05$), and predictive power of the model was enhanced by adding a function of buffer strip width ($P < 0.05$). This study emphasises the importance of integrating buffer strip characteristics in risk mitigation in agricultural streams. Based on the correlation between BSW and TU, we link BSW to the SPEAR index and estimate a minimum BSW required to mitigate effects of pesticide contamination in lowland streams in rural areas that are subjected also to contamination from insecticides.

NITROGEN CYCKLING IN A LOWLAND MACROPHYTE STREAM

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Release of ¹⁵N-labelled ammonium has been used to study N cycling in a range of stream types but until now never in a lowland macrophyte rich stream. We conducted a 12-day ¹⁵N-ammonium release in a 63 L/s Danish lowland stream dominated by *Ranunculus aquatica* and *Callitriche* sp. to assess N- flux pathways in a macrophyte-dominated stream. Macrophyte dominated streams are expected to function differently in N cycling compared to forested headwater streams and open streams without macrophytes. We expected that macrophyte dominated streams will have more nitrogen retention and flux into the food web because water exchange is slowed, and there is greater biologically active surface area. Macrophytes stayed labeled up to 100 days after enrichment. The epiphytes on the macrophytes were highly active and reflecting water nitrogen content. The uptake length for ammonium was 303 m indicating that the ammonium pool was turning over rapidly. The effect of macrophytes on the nitrogen cycling in streams will be discussed.

Session IV
Linkages in ecosystems:
from individuals to communities and back again

FRESHWATER METACOMMUNITIES: WILL THEY BE AFFECTED BY CLIMATE CHANGE?

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Metacommunity ecology is a recent discipline that considers community dynamics over a range of spatial and temporal scales. Metacommunity ecology emphasizes connectivity between habitats, whereby dispersal of organisms plays an important role (Leibold et al. 2004; Holyoak et al. 2005) and is defined as “Local communities that are interconnected at the regional scale by dispersal”. So far most metacommunity research is based on theoretical concepts which take into consideration the interaction of environmental conditions of habitats as well as their spatial position in landscapes, and how these factors influence ecological communities, while empirical studies are rather scarce (e.g. Vanschoenwinkel et al. 2007; Driscoll & Lindenmayer 2009). Empirical testing of these theoretical concepts is highly desirable for understanding landscape-level impacts of human stressors. Understanding how for example habitat fragmentation or pollution affect ecological communities at the landscape levels holds great potential for addressing biodiversity- and conservation related issues e.g. in freshwater ecosystems. In this paper we describe the four main theoretical concepts; patch dynamics, species sorting, mass effects, and the neutral view and give example of these from landscape-level and experimental freshwater ecosystems. Metacommunity ecology forms a theoretical framework, which can be used to better our mechanistic understanding and predictive ability of biotic responses to environmental change. Here we focus on already observed as well as plausible environmental changes related to climate change and how freshwater metacommunities can be affected by these changes. We will also discuss if and how we can adapt and mitigate to climate change related impacts on freshwater metacommunities.

LOOKING FROM THE BOTTOM UP: TEMPERATURE DEPENDENT LINKAGES AMONG NUTRIENTS, ALGAE AND GRAZERS

Nikolai Friberg

The response to nutrients were investigated in 9 geo-thermal, sub-arctic streams in Iceland. The experimental design consisted of reach scale additions of nitrogen in two successive growing seasons (summers of 2006/7) and use of nutrient diffusion substrates in 2007 which is the focus of this study. Previous trials with diffusion substrates have shown strong nitrogen limitation of the systems independent of temperature (range: 6.8-23.5 °C) and an additional effect of phosphorous in the warmest streams (Friberg *et al.* 2009). Moreover, strong indications have been found that nutrient uptake rates and transfer increase with temperature in these streams (Woodward *et al.* 2010; Rasmussen *et al.* 2011). However, algal biomass on natural substrates do not differ with temperature, which, together with high grazer biomass in the warmer streams, indicates that top-down regulation of algae could be temperature dependent. A grazer exclusion treatment in the diffusion substrates confirmed a very strong top-down effect with temperature. Furthermore, nitrogen was still highly limiting for primary production even in reaches where N had been added. This study supports the contention that streams with increasing temperature are highly efficient in transferring energy through the food web and much more receptive to nutrient additions. High densities and high average condition factor of trout (*Salmo trutta*) in warmer streams can be inferred as indicators of increased secondary production with temperature. Our results suggest that increased temperature, e.g. as a consequence of global warming, will change stream ecosystem functioning and susceptibility to eutrophication.

PORE-RESPIRATION IN SOME SMALL DIVING BEETLES

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Some small diving beetles can survive submerged through weeks and months, because they can extract oxygen, dissolved in the water. The exchange is diffusion, through specialized respiratory pores in their integument. A tracheated glomerule terminates the tracheal nexus from the interior to the surface of the pore. An air flux from the outside to the inside through the respiratory pores has been demonstrated. All diving beetles, capable of such pore respiration, are small, but not all small diving beetles have pore respiration. With increasing size, more and more of the surface must be covered by respiratory pores to meet the increasing demand of oxygen, and the decreasing surface in relation to volume. In running water species, the pore-respiration mode is regarded an adaptation to life in current exposed substrates, thus they avoid the risk of being swept away during frequent surface visits. In stagnant water species, the pore respiration mode reduces the risk of falling victim to pelagic predators. The submersion tolerant species can switch to surface respiration, e. g. during low oxygen content. The pore respiratory mechanism is believed to be a specialized plastron. A competing theory favors a tracheal gill. The oxygen flux through the scattered, small respiratory pore area (< 10% of total area) may be enhanced by a special configuration of the boundary layer covering their surface. This phenomenon has an analogy in plants stomata. In this system, circumference of the pores rather than their area determines the flux. This may explain why a species living on mud bottom has star shaped pores, while species living in streams have circular pores.

Poster Session

THE STRUCTURE OF ZOOPSAMMON COMMUNITIES OF LAKE VÕRTSJÄRV AND LAKE SAADJÄRV (ESTONIA): A PILOT STUDY

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Very little is known about organisms and their life in psammon in Estonia and when considering food webs or community structure it is poorly studied worldwide as well. Rotifers, nematodes, ciliates, testaceans, tardigrades, oligochaetes, small crustaceans, gastrotrichs, oribatid mites, turbellarians, acanthocephalans and larvae of flies have been found from psammic zone of eutrophic L. Võrtsjärv and mesotrophic L. Saadjärv during a study carried out in 2008 in Estonia. The objective of our research was to provide a preliminary overview of the structure of the zoopsammon communities, of some factors influencing the communities, and of seasonal changes in the communities. The overall zoopsammon population density in either lake was the lowest in spring and the highest in L. Saadjärv in July and in L. Võrtsjärv in September. The population densities of different zoopsammon groups varied greatly during the vegetative period, most abundant were nematodes, ciliates, rotifers and occasionally oligochaetes. The zoopsammon population density in L. Võrtsjärv in spring and the first half of summer was generally the highest in the hydropsammon zone while in the second half of summer and in autumn the majority of animals were found in the hygropsammon and eupsammon. Significant relation occurred between vegetation coverage rate and population density of nematodes and ciliates: higher nematode population densities occurred with higher vegetation coverage rates, whereas ciliates were most abundant with medium vegetation coverage rate. Coarseness of sand affected clearly only bdelloid rotifer population density, as higher density rates occurred with finer sand. Wave strength and sand temperature had no detectable effect on population densities of any group. Oligochaetes appeared extremely abundantly in autumn, when psammic zone was covered with thick layer of decaying leaves.

ADAPTING TO CLIMATE CHANGE: DOES SHADING FROM RIPARIAN VEGETATION DECREASE STREAM WATER TEMPERATURE?

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Stream water temperature is an important regulatory factor affecting stream organisms, e.g. rate of growth, metabolism, life histories, distribution patterns, and tolerance to different pressures such as parasites, diseases and pollution. Among the most important factors in the heat budget of a stream are long wave radiation and solar short wave radiation. As a consequence, riparian vegetation is important in the regulation of water temperature since it reduces the amount of short- and long-wave radiation that reaches the stream water surface. Riparian forests along streams have been severely deforested as an effect of different land use management and hence the reduction in radiation has been damaged. As a consequence of climate change, stream water temperatures are expected to increase and restoration of riparian vegetation and thus increased shading is one way to mitigate this increase. In this study, which is part of the EU-funded REFRESH project we will present the setup and some preliminary data from a longitudinal study in 12 streams, situated in the agricultural landscape of southern Sweden. The aims of the study were to investigate: i) How long does a stretch of riparian vegetation need to be in order to decrease water temperature, ii) How long does it take for water temperature to rise when it runs into an non-shaded area from a shaded area?

THE INFLUENCE OF STREAM NETWORK STRUCTURE ON MACROINVERTEBRATE BIODIVERSITY PATTERNS IN A NORTHERN SWEDISH CATCHMENT

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One of the most frequently studied topics in aquatic ecology is the link between species distributions and environmental factors. In lotic ecology there has been much focus on identifying the main environmental drivers structuring species communities. Less studied is the importance of spatial factors in terms of connectivity between habitats within and across river networks, and how they interact with environmental characteristics to determine community structure. In this study, we analysed the relative influence of environmental and spatial characteristics on macroinvertebrate community structure in a Swedish headwater catchment (all streams with catchment areas <10 km²). Our main aim was to elucidate whether the structure of river networks can determine how species are distributed in different stream-types (stream-order groups) within the same stream network. Analyses were performed on 1st order streams (upstream sites) and 2-3rd order streams (downstream sites) separately. Results show that environmental factors were more important in upstream sites, while spatial factors (connectivity between sites) were more important for structuring communities in downstream sites. These results are interesting both to better understand what structures stream communities within a stream network, and from a more applied perspective as it suggests that the importance of preserving local and regional conditions may differ in different parts of a stream network.

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